REMARKS

General Remarks

This is a reply to the Office Action dated February 3, 2009. Currently claims 1-61 are pending in the application.

In item 1 of the Office Action, the Examiner rejected claims 21 and 52 due to the misspelling of the term "1-4-bis(tirethoxysilyl)benzene[.]", which has now been corrected in the amended claims to recite 1-4-bis(triethoxysilyl)benzene. Applicants thank the Examiner for noting this problem.

Claim 31 has been amended to more clearly recite the present invention so that it now recites:

> "organic, organometallic, or biological molecules to a surface of the pore walls of the porous framework material..."

Claim 1 has been similarly amended.

Remarks to Claim Rejections – 35 USC Section 112 Paragraph Two

The Examiner has rejected claims 32 and 44 under 35 USC Section 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 32, the phrase *"**and the colloidal crystal**"* has been removed.

The dependence of claim 44 has been amended to resolve the antecedent issue relating to the phrase *"**the mesoporous metaloxide**"*, with claim 44 amended to depend on claim 34 instead of claim 40.

Remarks to Claim Rejections – Double Patenting

The Examiner has rejected claims 1 and 31 on the ground of nonstatutory obviousness-type double patenting as being unpatentable over respective claims 1 and 6 of U.S. Pat. No. 6,960,551 to Ozin et al.

As noted by the Examiner, Ozin et al. disclose a functionalized, porous crystalline metal oxide framework material, and a process for making the same comprising polycondensing an appropriate organometallic compound in the presence of a surfactant. In claim 1 of Ozin et al., however, it is clearly stated that the claimed structure comprises:

"*a framework including metal atoms, oxygen atoms and at least one organic group bonded between at least two of said metal atoms so as to be* ***integral with said framework***"

This is in stark contrast to claim 1 of the present invention, which states that the material comprises:

"preselected organic, organometallic or biological ***molecules chemically attached to a surface of pores of the porous framework*** *through two or more chemical linkages."*

Comparing these elements of claim 1 in the present invention and Ozin et al., it is clear that the two inventions are not the same. As described in detail within the specification of the present invention in page 21, lines 32-33:

"...the HMOs represent a distinct class of materials compared to the PMOs because in the HMOs the desired bridge bonded organic functionality is located ***exclusively on the surface of the pore walls*** *and* ***not in both the surface and bulk regions of the pore walls****, which is a defining feature of the PMOs."*

With regard to claims 31 and 6 of the present invention and Ozin et al., respectively, claim 6 of Ozin et al. recites a process that requires porous material to be synthesized with the organometallic compound present while forming the porous structure with a surfactant. Specifically, claim 6 of Ozin et al. recites:

"...comprising the step of polycondensing an organometallic compound ***in the presence of a surfactant****..."*

This process, in which the organometallic compound is necessarily formed throughout the walls of the porous material, can be seen to be completely different from the process claimed in claim 31 of the present invention. Claim 31 requires first preparing a porous structure without an organometallic molecule, and subsequently chemically bonding the organometallic molecule to the pore walls of the porous framework. Accordingly, the disclosure by Ozin et al, would in no way lead one skilled in the art to the claimed invention. Clearly, the two step process of the present invention, in which the organometallic molecule is only bonded to the surface of the pore walls, is distinct and non-obvious relative to the very different method of Ozin et al.

Accordingly, Applicants respectfully submit that claims 1 and 31 provide materials and methods that are non-obvious relative to Ozin et al. Applicants kindly request the withdrawal of the double patenting rejection of these claims.

The Examiner has further provisionally rejected claims 1, 17 and 28-30 on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 26, 29-30 and 36 of co-pending Application No. 11/232,431 (Landskron et al.).

The Examiner describes claim 26 of Landskron et al. as teaching a porous material comprising a framework of atoms covalently bound to two or more organic bridging atoms. The Examiner has noted that claim 26 of Landskron differs from the claims of the present invention because of the requirement for periodicity in claim 26, but has deemed this difference as being obvious.

However, Applicants note that a very major difference between the present invention and Landskron et al. is that the material disclosed in claim 26 of Landskron et al. includes organic bridging groups throughout the material, as opposed to on the

surface of the pores as in the present invention. While Landskron and similar prior art references discussed in the specification of the present invention provide porous materials with **organic groups incorporated into the pore walls**, the present invention overcomes problems associated with such materials by providing an inventive solution in which organic, organometallic, or biological molecules are chemically **attached to surface of pre-existing pores** through two or more chemical linkages.

Accordingly, Applicants submit that claims 1, 17, and 28-30 of the present invention are non-obvious relative to Landskron et al. and kindly request that the double-patenting rejection be withdrawn.

Remarks to Claim Rejections – 35 USC Section 102

On page 5 of the Office Action, the Examiner has rejected claims 1-3, 6-7, 31, 33 and 37-38 under 35 U.S.C. 102(b) as being anticipated by Lyu et al. Applicants respectfully request reconsideration and withdrawal of this rejection for the reasons outlined below.

The Examiner explains in the Office Action that Lyu discloses a hybrid mesoporous metal oxide that is bound chemically to an organometallic molecule, namely a surfactant, via multiple chemical bonds. This is in stark contrast, however, to the material and method of making the same claimed in the present invention.

Unlike the present invention, Lyu et al. disclose, in columns 1 and 2 of page 2310, a material that is formed by adding an aqueous solution of metal oxide precursors to a surfactant solution and heating the mixture to obtain a mesoporous structure. In other words, **Lyu simply teaches a route to obtain an ordered mesoporous metal oxide using surfactants in a homogeneous formulation**. This is completely different from the present invention, which recites in claim 1 a hybrid mesoporous material formed by bonding organic, organometallic or biological molecules **onto the surface of a pre-existing porous structure**. Lyu therefore only provides a porous material, and clearly omits the key step of chemically attaching molecules to the pore surfaces.

Applicants therefore respectfully submit that none of the claims of the present invention are anticipated by Lyu et al.

The Examiner also rejects claims 1-3, 6, 8-9, 12, 17, 28, 31-34, 37, 39-40, 43, 48 and 59 under 35 U.S.C. 102(b) as being anticipated by Asefa et al. However, as described above in relation to Ozin et al. and Landskron et al., Asefa et al. disclose a material in which organic molecules are integrated into, as opposed to on the surface of, the mesoporous framework.

Specifically, Asefa et al. discloses in paragraph 1, column 1, page 867, the following:

"Here we describe a periodic mesoporous organosilica containing bridge-bonded ethene groups ***directly integrated into the silica framework****."*

In other words, the materials and methods taught by Asefa et al. are precisely the types of materials and methods upon which the present invention improves. A clear distinction between such materials and methods and those of the present invention is drawn on page 21 of the specification:

"It is to be emphasized that the HMOs described in this invention are quite distinct to all of the known PMOs disclosed in both the patent and open literature. These distinctions are illustrated in Scheme 1. Specifically, all known PMOs reported prior to the disclosure of the HMOs are synthesized in a process that involves the co-assembly of a silsesquioxane precursor and a surfactant or polymer template to create a PMO in which the organosilica material that comprises the pore wall is described as a homogeneous integrated matrix of the bridge bonded organic and silica constituents.

To be quite precise, ***the bridge bonded organic groups in the so-formed PMOs are located both on the surface of the pore walls and within the bulk regions of the pore walls. In contrast, the HMOs disclosed herein are instead synthesized by a procedure that involves the chemical anchoring of a silsesquioxane, through two or more chemical linkages, to the silanol groups on the pore surface of a pre-existing periodic mesoporous silica PMS****. Hence the disclosed HMOs are clearly synthesized in a distinct way compared to all the known*

PMOs, to be precise the HMOs are made by chemical grafting (anchoring, attachment, tethering) versus co-assembly for the PMOs, Furthermore the HMOs represent a distinct class of materials compared to the PMOs because ***in the HMOs the desired bridge bonded organic functionality is located exclusively on the surface of the pore walls*** *and not in both the surface and bulk regions of the pore walls, which is a defining feature of the PMOs."*

Applicants respectfully submit that the arguments provided in the above excerpt demonstrate with clarity the major difference between the present invention and prior art PMOs such as those disclosed in Asefa et al. Applicants therefore respectfully submit that none of the claims of the present invention are anticipated by Asefa et al.

Claims 1-3, 6-9, 12, 15-17, 20-29, 31-34, 37-40, 43, 46-48 and 51-60 are rejected by the Examiner under 35 U.S.C. 102(b) as being anticipated by Inagaki (U.S. Pat. No. 9,248,686). While the Examiner suggests that Inagaki teaches the binding of porous or mesoporous metal oxide framework materials with various organic groups (via at least two metal-to-organic covalent bonds), a close examination of the disclosure by Inagaki reveals that the porous materials of Inagaki are merely PMO variants in which an organic group is bound to least two metal atoms in the **main chain of the skeleton of the porous material** (see the Abstract of Inagaki). Note that the term *"skeleton"*, as used by Inagaki, is analogous to the term *"framework"* used in the present invention. Therefore, it is clear the materials and methods of Inagaki are PMO materials, as addressed in the background section of the specification, specifically on page 5 and 6 where PMO materials are discussed in detail.

The identification of the materials and methods disclosed by Inagaki as prior art PMO variants is made clear by the following excerpts from Inagaki:

"The porous materials comprise organic groups ***integrated into the inorganic porous structure***" (col. 1, lines 9-11)

"Therefore, one object of the present teachings is to provide improved mesoporous materials that contain ***one or more organic groups integral to the structure of the mesoporous materials****."* (col. 2, lines 6-9)

"In such a porous material, the organic group is integrated into at least a part of the porous skeleton and the ***base skeleton itself has a hybrid composition composed of organic and inorganic materials****. As a result, a porous material can be synthesized having a novel organic/inorganic structure, because* ***the organic group is integrally bound with in the skeleton by at least two metal atoms****. Consequently, the organic group forms a part of the skeleton and porous materials are taught in which the organic group is held within the porous material in a stable manner."* (col. 2, lines 19-28)

"One advantage of such a porous material is that the pore walls exhibit properties of the organic group ***without utilizing a surface organic layer. Further, the introduction of the organic group into the porous material does not substantially reduce the pore diameter and pore volume****, as is the case for porous materials formed with a surface organic layer."* (col. 2, lines 29-34)

"Further, the pore diameter (pore size) and pore volume of the porous material can be maximized, because ***the organic groups are integrated into the pore wall instead of being suspended from the surface of the pore wall****."* (col. 5, lines 40-43)

As mentioned above in arguments demonstrating the differences between the claimed invention and Ozin et al. and Asefa et al., PMO materials and methods of making the same are completely different from the novel materials and methods disclosed in the present invention. As noted in page 22, lines 17-27:

"All of the above is considered to represent a ***massive difference between the PMOs and HMOs from the point of view of their synthesis and structure****, where to repeat, in the* ***HMOs the bridge bonded organic groups are exclusively located on***

the pore wall surfaces whereas in the PMOs they are to be found both on the surface of the pore walls and in the bulk regions of the pore walls*. This difference is especially important when it comes to designing and tailoring the chemical and physical properties, function and utility of the PMOs compared to the HMOs.*

Hence the HMOs disclosed herein are (i) ***synthesized in a distinct way*** *to the PMOs and (ii) are* ***structurally distinct*** *to the PMOs. This is the basis of the distinctiveness of HMOs to PMOs."*

Further evidence of the difference between the claimed structure and method and those disclosed by Inagaki is provided in Figure 8 of the present invention, where it is shown that there is a significant decrease in both the pore diameter and the total pore volume when the material according to the invention is compared to the framework material. In contrast, Inagaki claims that this does not occur in his materials, as discussed in the following passage:

"Further, ***the introduction of the organic group into the porous material does not substantially reduce the pore diameter and pore volume****, as is the case for porous materials formed with a surface organic layer."* (col. 2, lines 31-34)

With regard to synthesis of the materials, the Inagaki discloses the following methods that differ dramatically from those employed and claimed in the present invention:

"Preferably, such porous materials are ***synthesized using a polycondensation reaction*** *of an organometallic compound having at least one organic group bound to at least two metal atoms. Preferably, at least one hydrolysis group also is bound to the metal atom of the organometallic compound. Further,* ***the polycondensation reaction is preferably performed in the presence of a surfactant****. If such an organometallic compound is polycondensed using the surfactant as a template,* ***a porous material can be obtained as a polycondensate*** *having a metal atom-organic group bond in a main*

chain, because the organometallic compound contains the metal atom-organic group bond." (col. 2, lines 47-58)

*"**The organometallic compound may be polycondensed as a sole skeleton component**, or other inorganic condensable compounds, such as alkoxysilane and the like, may be polycondensed with the organometallic compound as skeleton components."* (col. 11, lines 55-59)

The above passages show that Inagaki makes it very clear that the organometallic compound is incorporated into the skeleton during the process of fabricating the skeleton itself. Furthermore, Inagaki gives a specific example of the synthesis of a mesoporous material by this method in column 16, line 25. This is in sharp contrast to the method of the present invention, in which a pre-existing framework (i.e. skeleton) is employed wherein an organometallic compound is attached to the framework without the need for a polycondensation step, as evidenced in the following excerpts from the specification:

"The elegance of this invention is the simplicity of the underlying concept, namely a $(EtO)_3SiRSi(OEt)_3$ silsesquioxane precursor is chemically anchored through its alkoxysilyl groups to the silanol groups located on the channel surface of a pre-existing mesoporous silica in a very simple one step reaction." (page 9, lines 7-11)

"As example only, silsequioxanes of the general formula (RO)3Si-R'-Si(OR)3 can react through their alkoxysilyl groups with the pendant silanol groups of a porous silica framework to form two new Si-O-Si linkages between the silsesquioxane, and the framework, when the porous framework material is silica." (page 10, lines 13-17)

"In one aspect of the invention there is provided a method of synthesizing a hybrid porous material having a porous framework material and pre-selected organic, organometallic, or biological molecules chemically attached to a surface of pore walls of the porous framework through two or more chemical linkages, comprising the steps of:

a) preparing a porous framework material having pores and pore walls throughout with preselected porosity; and

b) chemically binding pre-selected organic, organometallic, or biological molecules to the pore walls of the porous framework material through two or more chemical linkages." (page 10, lines 23-32)

Specific examples of these methods are provided on page 17, lines 1-29. In all cases disclosed within the specification, the framework (skeleton) must already exist prior to the attachment of the organometallic material.

Applicants further note that a detailed discussion of the difference between the present invention and PMO materials and methods such as those provided in Inagaki is presented in the specification from line 15 of page 21 to line 27 of page 22.

In view of the above discussion and arguments, Applicants respectfully submit that none of the claims of the present invention are anticipated by Inagaki.

Claims 1-3, 6, 8-9, 12-13, 15, 17-18, 24, 27-28, 31-34, 37, 39-40, 43-44, 46, 48-49, 55, and 58-59 are rejected by the Examiner under 35 U.S.C. 102(b) as being anticipated by Fowler et al. The Examiner describes the disclosure by Fowler as providing a hybrid mesoporous organometallic oxide, bearing an organic group chemically attached to the oxide's porous framework.

However, as discussed in detail regarding the disclosure by Inagaki, it is important to examine the nature of the attachment of the organic group to the framework when comparing prior art disclosures to the present invention. While the present invention provides materials and methods in which an organic material is **attached to the surface of a pre-existing framework via two or more chemical linkages**, the materials of Fowler involve the **co-condensation of organic materials while forming the framework itself**. This is evidenced by the following passages within Fowler:

"An ordered organo-silica-surfactant mesophase containing a covalently-linked chromophore was synthesized with MCM-41-type architecture by ***template-directed co-condensation****"* (col. 1, lines 1-3)

"Here we extend this approach and show that an intact chromophore can be covalently incorporated into the MCM-41 mesostructure by ***direct chemical synthesis involving co-condensation****"* (col. 1, paragraph 2, lines 6-8)

Clearly this material has an organic material that is integrated directly into the entire structure of the framework, as opposed to only on the surface of an existing framework. As described in the specification and in the preceding arguments relating to Ozin et al., Asefa et al., Lyu et al. and Inagaki, this material and its method of fabrication is completely different from the materials and methods of the present invention.

In view of the foregoing amendments and remarks, reconsideration and withdrawal of the judicially created double patenting and 102(b) rejections is respectfully solicited and favorable consideration and allowance of the cited claims is requested. In summary, in light of the above arguments regarding the patentability of the claims of the present invention, Applicants respectfully submits that all amended claims are definite and not anticipated, nor obvious in view of, the cited references. Accordingly, Applicants kindly request that the pending claims 1 to 61 be allowed.

Applicant submits that the amendments are to more clearly and succinctly recite and claim the present invention. It is respectfully submitted that all the amendments are supported by the original specification as a whole and therefore no new matter has been added by these amendments.

Should the Examiner have any questions regarding the allowability of the claims it would be appreciated if the Examiner would contact the undersigned attorney-of-record at the telephone number shown below for further expediting the prosecution of the application.

Respectfully submitted,

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